Zero-Magnetic-Field Phase-Decoherence Transition in Underdoped La$_{2-x}$Sr$_x$CuO$_4$\textsuperscript{1} PAUL BAITY, XIAOYAN SHI, ZHENZHONG SHI, DRA- 
GANA POPOVIĆ, Dept. of Phys. & Natl. High Magnetic Field Lab., Florida State 
Univ. — The two key prerequisites for superconductivity are electron pairing and 
phase coherence of the pair wave-function. We present an electrical transport 
study on underdoped La$_{2-x}$Sr$_x$CuO$_4$ (LSCO) films ($x = 0.07$ and 0.08) that suggests that, 
in zero magnetic field ($H = 0$), superconductivity is destroyed by thermal unbind-
ing of vortex-antivortex phase fluctuations at a temperature $T_{BKT}$. In particular, 
current-voltage ($I - V$) curves follow a power law $V \propto I^{\alpha(T)}$ with $\alpha(T) \geq 3$ for 
$T \leq T_{BKT}$. In addition, the contribution of the superconducting fluctuations to the 
conductivity, $\Delta\sigma_{SCF}(T, H = 0)$, obtained by extrapolating the measured magnetores-
istance from the normal state at high enough $H$ and $T$, increases monotonically 
with decreasing $T$ and diverges exponentially at $T_{BKT}$. These results suggest that 
the $H = 0$ superconducting transition, where the Ohmic resistivity also vanishes, is 
due to the loss of phase coherence and manifests itself as a Berezinskii-Kosterlitz-
Thouless transition. Our findings agree well with other experiments on LSCO with 
higher doping.

\textsuperscript{1}Supported by NSF DMR-0905843, DMR-1307075, NHMFL via NSF DMR-1157490, 
and the State of Florida.

Paul Baity
Dept. of Phys. & Natl. High Magnetic Field Lab., Florida State Univ.

Date submitted: 14 Nov 2013 Electronic form version 1.4